Farnell

D SERIES
BENCH POWER SUPPLIES

INSTRUCTION BOOK

MP MASTER
MA23412

INSTRUCTION BOOK
FOR

D SERIES
BENCH POWER SUPPLIES

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SCHEDULE OF EQUIPMENT

The instrument has been carefully packed to prevent damage in transit. When removing the unit from the box, be sure to remove all parts and accessories from the packing material.

The complete equipment comprises:

1 off D Series bench power supply (as ordered)
1 off Instruction book
1 off Red DVM input plug
1 off Black DVM input plug

Note:- In the event of damage in transit or shortage in delivery, separate notices in writing should be given to both the carriers and Farnell Instruments Limited, within three days of receipt of the goods, followed by a complete claim within five days. All goods which are the subject of any claim for damage in transit or shortage in delivery should be preserved intact as delivered, for a period of seven days after making the claim, pending inspection or instructions from Farnell Instruments Ltd., or an agent of the Company.

INTRODUCTION

This instruction book is intended to cover the entire D range of bench power supplies and the information supplied applies to all models, except where otherwise stated. However, the circuit diagrams supplied with the book apply only to the particular model bought.

On all models, the output voltage is continuously variable from approximately zero to the rated output by means of a 10 turn potentiometer. Current control is continuously variable from approximately 1% of maximum output to the rated maximum output by means of a single turn potentiometer.

Metering of the output voltage and current is dependent upon the model and is accomplished by either a single DPM, switched for volts or amps, or by two DPMs measuring volts and amps separately. On all models the voltmeter can be used to measure an external voltage.

The output of each power supply (or section) can be switched on and off by means of the output on/off switch. With this switch in the 'OFF' position, the output voltage and prospective current limit setting can be set prior to connecting the load. When switched to the 'ON' position, separate LEDs are illuminated indicating whether the unit is operating in a constant voltage (green) or constant current (red) mode.

Units available:

D30-2	0-30V at 2 amps, single output
D30-2T	0-30V at 2 amps, twin outputs
D30-4	0-30V at 4 amps, single ouput
D100-1	0-100V at 1 amp, single output

SPECIFICATION

MAINS INPUT	110, 220, 240V a.c. 48-63Hz Tolerance: ± 10%
LINE REGULATION	
Constant voltage mode	± 0.01% + 2mV for ± 10% mains change
Constant current mode	± 0.1% + 1mA for ± 10% mains change
LOAD REGULATION	
Constant voltage mode	± 0.01% + 2mV for zero to full load change (± 0.02% + 5mV for D100-1)
Constant current mode	± 0.1% + 1mA for zero to full load change
RIPPLE AND NOISE	
Constant voltage mode	< 2mV pk-pk at full load
Constant current mode	1mA pk-pk typical at full load
OUTPUT IMPEDANCE (constant voltage)	2mΩ typical at 1kHz, 23°C
TRANSIENT RECOVERY TIME	25μs (typical) to recover within 50mV following a 10% to 100% load change
TEMPERATURE COEFFICIENT	0.01% per °C, typical
OVERLOAD PROTECTION	Adjustable current limiting from 1% to maximum. Constant current (i.e. current limit) indicated by front panel LED. Further protection offered by output fuse mounted on base.
METER (S)	4 digit, 12.5mm high red LED
VOLTMETER	
Range	0-39.99V (30V units) 0-399.9V (100V unit). Overrange indicated by OFL
Resolution	10mV (30V units) 100mV (100V unit)
Accuracy	± 0.2% reading ± 0.1% full scale at 23°C
EXTERNAL VOLTAGE MEASUREMENT	By push button selection. The voltmeter can be used to measure external voltages in the range 0-39.99V for 30V units and 0-399.9V for 100V unit, via front panel sockets.
Input impedance	1MΩ approx.
Isolation	Input sockets are fully isolated from output terminals when operated in external mode. The input terminals must not float at more than 200V peak from chassis potential.
CURRENT METER	
Range	0-3.999A Overrange indicated by OFL
Resolution	1mA
Accuracy	± 0.3% reading ± 0.1% full scale at 23°C

TEMPERATURE RANGES	
Operating temperature	0°C to 40°C
Storage temperature	-20°C to +60°C
DESIGN	Units are designed to meet IEC348/BS4743 safety requirements for electronic test and measuring apparatus.

MECHANICAL (ALL APPROX)

Unit	Height (mm)	Width (mm)	Depth (mm)	Weight (kg)
D30-2	170	120	310	5.3
D30-2T	170	220	310	7.8
D30-4	170	220	310	7.8
D100-1	170	220	310	7.8

OPERATING INSTRUCTIONS

Installation

Check that the input voltage setting is correct for the local mains supply. The instrument is normally supplied with the mains input set for 240V a.c., any other setting will be marked upon the base.

In order to change the input voltage setting, the following procedure should be followed. Disconnect the unit from mains. Remove the handle (2 screws) and the top cover (4 screws). Amend the links to suit the desired voltage. Note that for 240V operation, the two primaries are connected in series but that for 110V operation, the primaries must be connected in parallel (0 to 0 and 110 to 110V). Connect feed from the mains switch to 0 and 110V taps. Change the mains input fuse to one with a suitable rating for the new input voltage. Amend the label (with indelible ink) on the base of the unit to show the new voltage setting.

Connect a suitable mains plug to the mains cable, observing the following colour code:

Live-Brown Neutral-Blue Earth-Green/yellow

Warning: The earth line must be connected at all times. The unit is cooled by natural convection and on no account should the airflow around the unit be restricted. The heatsinks at the rear of the units reach high temperatures and so contact should be avoided.

Operation

With the output switch (es) in the 'OFF' position, depress the 'INPUT' switch to the 'ON' position. The LED digits will illuminate and the power supply is ready for adjustment. Note that the Constant Voltage (CV) and Constant Current (CI) LEDs are not illuminated with the output switched 'OFF'.

To set the output voltage, depress the push button marked 'V' (or'int') and adjust the ten-turn voltage control to give the desired value of output voltage on the LED meter.To set the output current limit, adjust the current control, after depressing the I push button (when fitted) to give the desired current limit figure.The power supply is now ready for use.

Connect the load to the output terminals and depress the output switch to the 'ON' position. Provided that the actual current drawn by the load is less than the current limit setting, the unit will work in the Constant Voltage mode and the green 'CV' LED will be illuminated.

If the load current reaches the previously set current limit level, the power supply will work in the Constant Current mode and the red 'CI' LED will illuminate. The changeover from 'CV' to 'CI' is automatic.

Note:

Although the current control can be used to limit the d.c. current down to about 1% of maximum output, the instantaneous current under limit conditions is independent of any such setting. This is because the output capacitor, which is needed for stability and transient response, is charged to the output voltage. The instantaneous current is thus a function of output voltage, the value of output capacitor, lead and source impedance and the load impedance.

Remote sensing

Provision is made on high output current units for remote sensing of the output voltage at the load end. This virtually eliminates the voltage drop along the output leads. To make use of this facility, remove the two shorting links between the sense and output terminals. To avoid instability, the same polarity load and sense wires should be twisted tightly together. Alternatively, a coaxial cable may be used, the inner wire being connected to the sense terminal. The voltage drop in each output lead must not exceed 0.5 volts.

In all applications the use of a capacitor wired directly across the load will improve transient performance and stability.

Both of the output terminals are fully floating and either may be connected to earth. Alternatively, either terminal may be floated up to a maximum of 200V d.c. above chassis (safety earth)

External DVM

All D range models can be used to measure external voltages up to a maximum of 39.99V on 30V units and 399.9V on 100V units. To switch the meter to read external volts, the following procedure should be followed. On units with a single meter, simultaneously depress the push buttons marked 'V' and 'I' and on units with separate meters for volts and amps, depress the button marked 'EXT'.

In the external DVM mode both inputs to the voltmeter are fully isolated from the power supply outputs. However, the DVM inputs should not be floated at greater than 200 volts or a.c. peak from any power supply output or chassis (safety earth).

Application of external voltages

Diode protection is provided against application of an external voltage greater than the set output of the power supply. Diode protection is also provided against the application of reverse voltages. Protection is only offered up to a current flow equal to the maximum output current of the unit. (Remember that the current flowing will be a function of the source resistance of the external voltage, and the external voltage).

CIRCUIT DESCRIPTION

The description of the D range of bench power supplies can be conveniently split into two specific areas, the control circuit and the display circuit.

Control circuit

The output circuit comprises series regulator transistors in parallel, fed with bridge rectified d.c. from the transformer and controlled by voltage loop and current loop comparators.

The mains input supply is connected through the protection fuse F1, via the front panel mounted 'INPUT' switch, to the appropriate tappings on the mains transformer. One secondary provides unregulated d.c., via a bridge rectifier, BR2, and reservoir capacitor (s) C12 (C14), the positive feeding the series regulator, whilst the negative is taken via a protection fuse F2 (F3) to the negative output terminal. The output from the series regulator is taken via emitter sharing resistors, through the current monitoring resistor R44 (R51), to the output on/off switch, which interrupts the feed to the positive terminal. Since the series regulators are responsible for the bulk of heat dissipation, they are mounted external to the unit on heatsink assemblies at the rear.

The supply for the control circuitry is obtained from a further secondary on TX1, rectified by BR1 and smoothed by C2. The resultant smoothed d.c. is fed through R1 to Z1 and Z2, two zener diodes in series. This provides a positive 8.2 volt nominal line and a negative 5.6 volt nominal line, about their junction.

The two lines are then used to power the integrated circuit control amplifiers and their associated circuitry.

One half of a LM358 dual operational amplifier (IC1) is used in the voltage control loop. The inverting input and the -ve of the band gap reference zener, Z3, are taken to the junction of the two supply regulating zeners and form the + ve sense line. The positive of Z3 is connected across the front panel voltage control (P2) and feeds a proportion of the reference voltage, dependent upon its angular position, to the top end of a potential divider formed by R4 and R12. The junction of R4 and R12 is connected to the non-inverting input of the amplifier, with the bottom end of the potential dividers being connected to the -ve sense line.

The operational amplifier will endeavour to keep the junction of R4 and R12 and the + ve sense line at the same potential. Hence the output voltage is given by:

$\frac{Va.\ R12}{R4}$ where Va is the voltage at the wiper of the front panel voltage control potentiometer (P2)

The current control loop utilises the other half of IC1 and uses a separate band gap zener, Z4, as a reference voltage. A voltage is available at the wiper of the circuit control potentiometer (P4) which is dependent upon its angular position. This voltage is fed to the non-inverting input. The inverting input is taken to one side of the current sensing resistor, R44.

As long as the voltage across R44 is less than the voltage on the non-inverting input, D4 is reverse biased and control is maintained by the voltage loop. As soon as the voltage across R44 equals the reference voltage, the comparator changes state and maintains control of the series regulators via D4. This holds the output current constant.

IC2 is used to drive the LED mode indicators by sensing the output state of the current loop amplifier. With the output switch 'OFF' (i.e. SW2 open), no current can flow and thus neither LED is illuminated.

When the output switch is 'OFF', TR1 is also 'off' and thus pins 6 & 13 of IC3 are held high by R29. IC3 is a switch and, in the state of pins 6 & 13 being high, allows the current display to monitor the reference voltage available from the wiper of P4. Thus, when the output switch is 'OFF', the prospective current limit setting can be displayed.

With the output switch in the 'ON' position, TR1 is turned on and thus pins 6 & 13 are held low. In this mode, IC3 allows the voltage across R44 to be displayed on the current meter, thus displaying the actual current flowing. With the output switch ON', either the green 'CV' LED or the red 'CI' LED is illuminated, dependent upon the output state of the current loop amplifier of IC1 and in turn, the output of IC2.

Display circuit

Some of the units in the 'D' range use a single digital meter, switched to read either output voltage or current, whilst others use two digital meters, one connected to monitor voltage and the other to monitor current.

The basic digital voltmeter has a FSD of 399.9mV and utilises a voltmeter chip (ADD3701CCN) driving a 4 digit, 7 segment display. A.C. from a secondary on TX1 is bridge rectified, smoothed by a capacitor and then regulated by a fixed 5V regulator to provide a nominal 5V supply for both the display and the voltmeter chip. Separate analogue and digital star grounds are provided to prevent current loops affecting the reading. The 'on chip' oscillator controls the sampling and multiplex frequency. The oscillator frequency is determined by the resistor and capacitor connected to pin 19.

The decimal point is also multiplexed and, in order to synchronise this with the appropriate digits, the base of the decimal point driver transistor (BC212PL) is fed from the corresponding drive transistor.

The analogue reference voltage at pin 18 is nominally 2 volts. This is derived by a potential divider and adjustment potentiometer (set FSD) across a band gap reference zener (Z1). Pin 14 is the feedback sensing function of the integrated circuit and the feedback voltage from pins 17 and 16 is divided by approximately 5 by the 390K and 100K resistors. The 220nF capacitor connected to pin 14 provides smoothing of the switched waveform which is then compared with the input voltage on pin 11. Zero offset current is provided via the 'set zero' potentiometer connected across the bandgap reference source.

Also included is the necessary switching to allow the digital meter to monitor the power supply output voltage or an external voltage and, where appropriate, to monitor output current. The display board also contains the necessary input dividers and calibration potentiometers.

MAINTENANCE

Guarantee

The equipment supplied by Farnell Instruments Ltd., is guaranteed against defective material and faulty manufacture for a period of twelve months from the date of despatch. In the case of material or components employed in the equipment but not manufactured by us, we allow the customer the period of any guarantee extended to us.

The equipment has been carefully inspected and submitted to comprehensive tests at the factory prior to despatch. If, within the guarantee period, any defect is discovered in the equipment in respect of material or workmanship and reasonably within our control, we undertake to make good the defect at our own expense subject to our standard conditions of sale. In exceptional circumstances and at the discretion of the Service Manager, a charge for labour and carriage costs incurred may be made.

Our responsibility is in all cases limited to the cost of making good the defect in the equipment itself. The guarantee does not extend to third parties, nor does it apply to defects caused by abnormal conditions of working, accident, misuse, neglect or wear and tear.

Maintenance

In the event of difficulty, or apparent circuit malfunction, it is advisable to telephone (or telex) the Service Department or your local Sales Engineer or Agent (if overseas') for advice before attempting repairs.

For repairs and recalibration it is recommended that the complete instrument be returned to:-

The Service Department,
Farnell Instruments Ltd.,
Sandbeck Way,
Wetherby,
West Yorkshire.
LS22 4DH
Tel. 0937 61961 Telex 557294

or

The Service Department,
Farnell Instruments Ltd.,
Davenport House,
Bowers Way,
Harpenden, Herts.
AL5 4HX
Tel. 05827 69071 Telex 826307

Please ensure adequate care is taken with packing and arrange insurance cover against transit damage or loss.

RECALIBRATION

Repair and recalibration should only be attempted by personnel fully conversant with the hazards of working on a.c. mains powered equipment.

The safety earth must be connected at all times and the protective covers must be in place except when their removal is necessary for access. A.C. mains power should only be applied when essential for testing and recalibration. If necessary, the unit can be returned to Farnell Instruments Limited, or their agents, for repair and recalibration.

1. Control circuit [all units]

The three preset controls can be adjusted, using an insulated tool, via holes in the base of the unit. The front panel, complete with boards, can be removed from the chassis if required, to give better access.

1.1. Check that all fuses are of the correct value and type. Turn the front panel controls to mid range and ensure that the output switch is set to 'OFF'.

1.2. Connect a reference voltmeter of known accuracy across the output terminals. (If the units own voltmeter is known to be working it can be used in place of the reference voltmeter by depressing the push button marked 'V').

1.3. Depress the output switch to the 'ON' position. Turn the voltage control fully anticlockwise and check that the voltmeter indicates less than 50mV.

1.4. Rotate the voltage control fully clockwise and, using an insulated tool, adjust P1 (set to max o/p V) to give an output of approximately 31.00V (or 102V on D100-1).

1.5. With a load connected in series with a reference ammeter of known accuracy, turn the current control fully clockwise and, using an insulated tool, adjust P3 (set max o/p I) to give a reading on the reference ammeter of approximately 1.1A for the 1A unit, 2.1A for the 2A units and 4.2A for the 4A unit. Note that throughout this operation the red 'CI' indicator should be illuminated.

1.6. If necessary, the internal ammeter can be calibrated at this stage. See 2.12 or 3.14.

1.7. Turn the current control fully anticlockwise and turn the output switch to the 'OFF' position. Note the reading on the internal ammeter.

1.8. Return the output switch to the 'ON' position. Using an insulated tool, adjust P5 (set zero offset CI) to give an identical reading to that obtained in 1.7.

1.9. Repeat stages 1.7 and 1.8 with the current control set to full output current (fully clockwise). Adjust P5 to give a reasonable compromise between the variations in maximum and minimum currents.

2. Display board

Display board with a single meter switched between volts and amps [D30-2, D30-2T]

2.1. Remove secondary fuse (s) F2 (3).

2.2 Using a d.c. voltage source with an accuracy of better than 0.05%, apply 1mV to the test pins on SK2 (+ ve to + and -ve to -).

2.3. Adjust P2 (set zero) to give a reading of 010 on the display.

2.4. Apply 350mV and adjust P1 (set f/s) to give a reading of 3500.

Return the voltage source to 1mV and check that the reading is still 010 If not, repeat steps 2.2 to 2.4.

2.6. To check the linearity of readings, apply the following voltages and confirm that the meter reads within 0.1% of reading + 4 digits (i.e. 0.1% of full scale), 1mV, 10mV, 70mV, 100mV, 200mV, 350mV and 390mV

2.7. Remove the connections to the test pins and reconnect any separated connectors. Replace the secondary fuse(s).

2.8. Select 'ext DVM' operation and apply a short circuit across the input terminals.

2.9. Adjust P2 to give a reading of 001 and then back off to just give a reading of 000.

2.10. Apply 35V d.c. from the voltage source to the external DVM terminals and adjust P3 (Cal. V) to give a reading of 35.00V on the voltmeter.

2.11. For twin units only. Depress both the 'V' and 'I' push buttons on the left hand section and, after making connections to the two most rearward contacts on the 'I' push button switch, repeat steps 2.8 to 2.10.

2.12. Provided that the control section is working, adjust the controls so that nearly the full output current is flowing through a reference digital ammeter of known accuracy. Select the 'I' push button and adjust P4 (Cal I) so that the same value is indicated on the meter on the unit under test as on the reference ammeter.

3. Display board

Display board with separate voltmeter and ammeter [D30-4, D100-1]

3.1. Remove secondary fuse, F2, and Plug 1

3.2. Using a d.c. voltage source with an accuracy of better than 0.05%, apply 1mV to the test pins on SK3 (+ ve to + , -ve to -).

3.3. Adjust P3 (zero) to give a reading of 010 on the voltmeter.

3.4. Apply 350mV and adjust P1 (set f/s) to give a reading of 3500.

3.5. Return the voltage source to 1mV and check that the reading is still 010. If not, repeat steps 3.2 to 3.4.

3.6. To check the linearity of readings, apply the following voltages and confirm that the meter reads within 0.1% of reading + 4 digits (i.e. 0.1% of full scale), 1mV, 10mV, 70mV, 100mV, 200mV, 350mV and 390mV.

3.7. Remove the connections to the test pins on SK3 and connect to SK4.

3.8. Repeat steps 3.2 to 3.6. This completes the basic setting up of the ammeter (using P8 as set zero and P7 as set full scale).

3.9 Remove the connections to SK4. Plug in connector SK1.

3.10. Select 'ext DVM' operation and apply a short circuit across the input terminals.

3.11. Adjust P2 to give a reading of 001 and then back off to just give a reading of 000.

3.12. *D30-4 only.* Apply 35V d.c. from the voltage source to the external DVM terminals and adjust P3 (Cal V) to give a reading on the voltmeter of 35.00V

D100-1 only. Apply 100V d.c. from the voltage source to the external DVM terminals and adjust P3 (Cal V) to give a reading on the voltmeter of 100.0V.

3.13. Switch the output switch to the 'ON' position and, with no load connected, adjust P8 (zero) to give a reading of 001 and then back off to just give a reading of 000.

3.14. Provided that the control section is working, adjust the controls so that nearly the full output current is flowing through a load and a reference ammeter. Adjust P6 so that the same value is indicated on the ammeter on the unit under test as on the reference ammeter.

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